Wildcat Creek-

Monitoring Station- SC652
USGS Gaging Station- None
Included area-
HUC 8: 10270101
HUC 10: 02
HUC 12: 04, 05

Streams flowing to monitoring station-

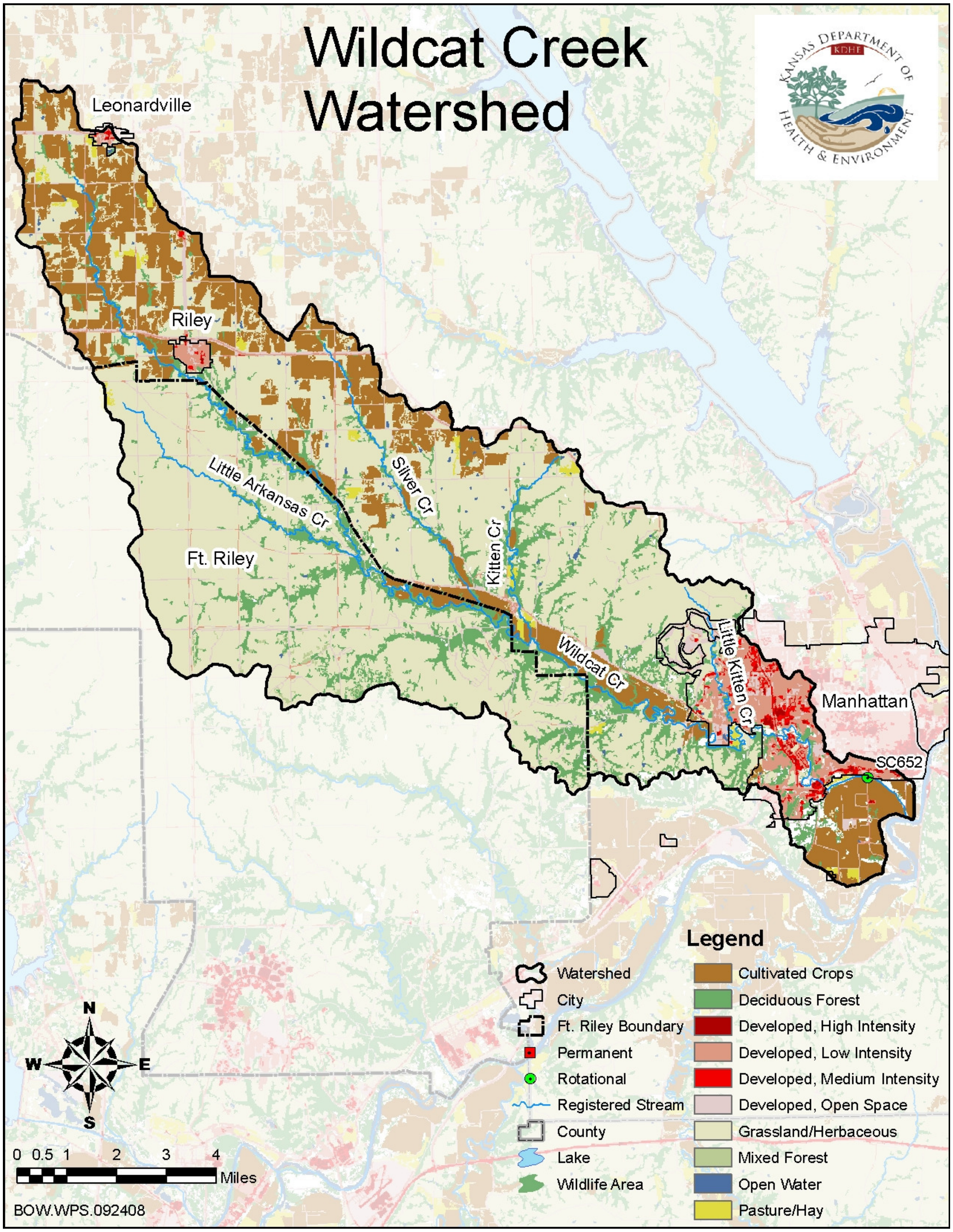
Name	Segment #
Wildcat Creek-	2
Silver Creek-	12
Little Arkansas Creek-	13
Kitten Creek-	14
Little Kitten Creek-	16

Land use-

Permanent Grass	55.61%
Cropland	18.84%
Forest	14.56%
Developed Land	10.68%

Counties- Riley
Cities- Manhattan, Riley, Leonardville, Ft. Riley housing lies outside the watershed, but significant training areas lie within
2000 Population- 21,545
Kansas House Districts-64, 66, 67, 106
Kansas Senate Districts- 21 & 22
Monitored Watershed Size- 98 square miles
2008 303(d) impaired waters- None
TMDLs- Bacteria, Dissolved Oxygen, approved 1/26/2000
NPDES Permitted Facilities- Riley MWTP (M-KS62-OO02), Leonardville MWTP (M-KS35-OO01), Manhattan MSSSS (Stormwater) (M-KS38-SN01)
Threatened and Endangered Species- Topeka Shiner (*Notropis topeka*)
Permitted Confined Animal Feeding Operations-7

Animal Type	Total Animals
Beef	130
Dairy	300
Swine	1,254



Stream Chemistry-

Wildcat Creek has a very poor ranking for total phosphorus, poor ranking for *E. coli*, and moderate rankings for total nitrogen and total suspended solids. Wildcat Creek experiences its highest pollutant concentrations during the spring season (April-July) some reductions during the summer/fall (August- October), and the lowest concentrations during the winter (November-March). While Wildcat Creek does not have a gaging station, these results are consistent with similar results in other gaged watersheds for areas experiencing runoff and high flow event contamination for sediment, phosphorus and organic nitrogen. However, not all pollutants share this trend. Inorganic nitrogen shows no seasonal behavior, with high concentrations occurring throughout the year, suggesting a groundwater input that leaches into these streams throughout the year. Total phosphorus shows low seasonality, suggesting that its loading may be decoupled from the suspended solids entering these streams. Total nitrogen, *E. coli*, and TSS show stronger signs of seasonality, consistent with runoff related pollution.

Wildcat Creek has an active TMDL for inadequate dissolved oxygen, based on a recorded sample at 4.5 mg/L in early August, 1997. State water quality standards mandate dissolved oxygen concentrations exceed 5 mg/L at all times to support aquatic life. Because Wildcat Creek is only monitored on the rotational schedule, less data are available to assess the compliance of the creek with water quality standards. In spite of the limited data, in early August, 2007, KDHE again recorded dissolved oxygen concentrations below water quality standards, this time at 4.95 mg/L. The sample, by chance, was subject to a quality control duplicate sample, which indicated a concentration of 5.29 mg/L. However, it should be noted that the sample was collected at 11:30 am, suggesting that dissolved oxygen concentrations during the night-time hours may be failing to meet water quality standards, given how close the late summer mid-day samples are to the minimum acceptable levels. Some speculation regarding the original low dissolved oxygen sample from 1997 focused on a low-water crossing bridge that created a large log jam and impeded the flow of the stream. The 2007 sample was taken after the crossing and the log jam were removed, suggesting that some causes of low dissolved oxygen remain.

Riley & Leonardville operate small lagoon wastewater treatment plants, which combined discharge about 160,000 gallons of wastewater per day. This is approximately 2.8% of the median estimated flow at the KDHE sampling point. BOD treatment from these facilities has been variable, but the distance between their outfalls and the KDHE sampling point suggest that other causes are larger factors influencing the swings in the dissolved oxygen in the downstream reaches of this stream. They may have larger effects in the upper reaches, but this has not been investigated. Dissolved oxygen is less soluble as water temperature increases, resulting in the typical U-shaped distribution of concentrations during the year. Late July and early August, when air temperatures are highest, are when we expect to see the lowest concentrations of dissolved oxygen.

A fecal coliform bacteria TMDL was established for this watershed in 2000. Recent sampling by KDHE crews was conducted to determine if this stream was in compliance with the new standard for *E. coli*, which requires five samples to be taken within 30 days. The stream consistently failed to meet expectations, and is confirmed as impaired by *E. coli* bacteria under current water quality standards.

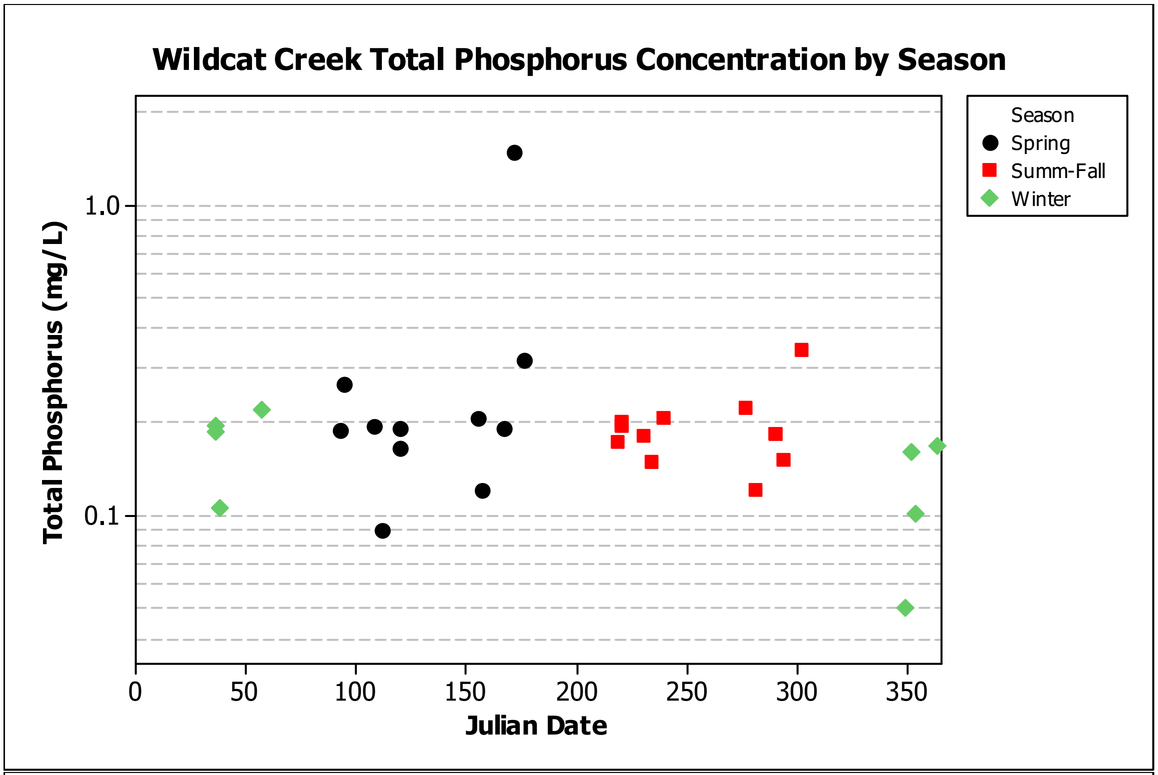
The strong seasonal nature of some of the contaminants suggests that measures targeting soil erosion, including stream bank stabilization, and buffering of streams from cropland will have significant beneficial impacts. Strategies for reducing livestock interaction with streams will likely have positive impacts on the observed bacteria levels. While no data was available to us, previous studies in areas with heavy track-vehicle use, as might be expected in the areas of the watershed used by Ft. Riley for training, have documented increased sediment loads from erosion on both upland areas and stream crossing sites.

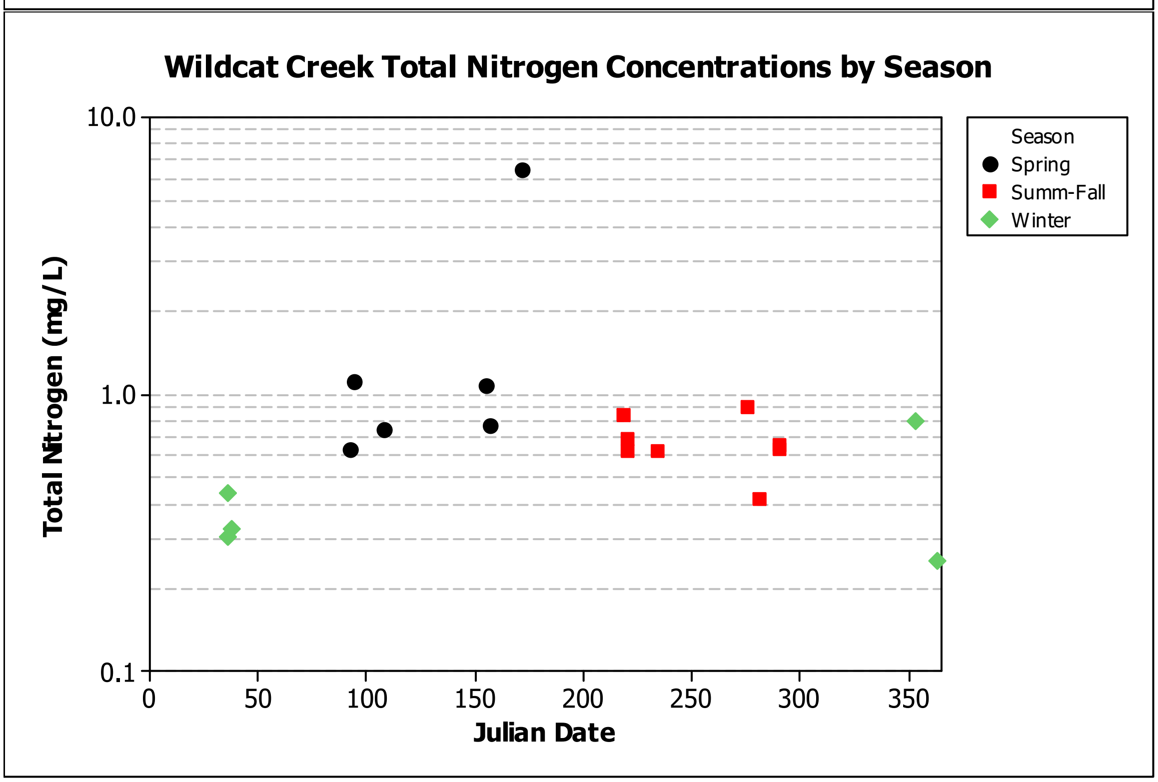
Wildcat Creek is unique in the project area for its combination of urban land use, federal lands, and the lack of major wastewater discharges. Anecdotal accounts of litter and trash in the stream reaches flowing through Manhattan suggest that efforts to improve water quality in this area will require support from urban residents and government. Concentrated urban populations, and the presence of a major state university present an opportunity to partner on efforts to improve water quality along Wildcat Creek, and ensure that ongoing development in the western part of Manhattan occurs in a manner that is consistent with long-term protection of water quality in this stream.

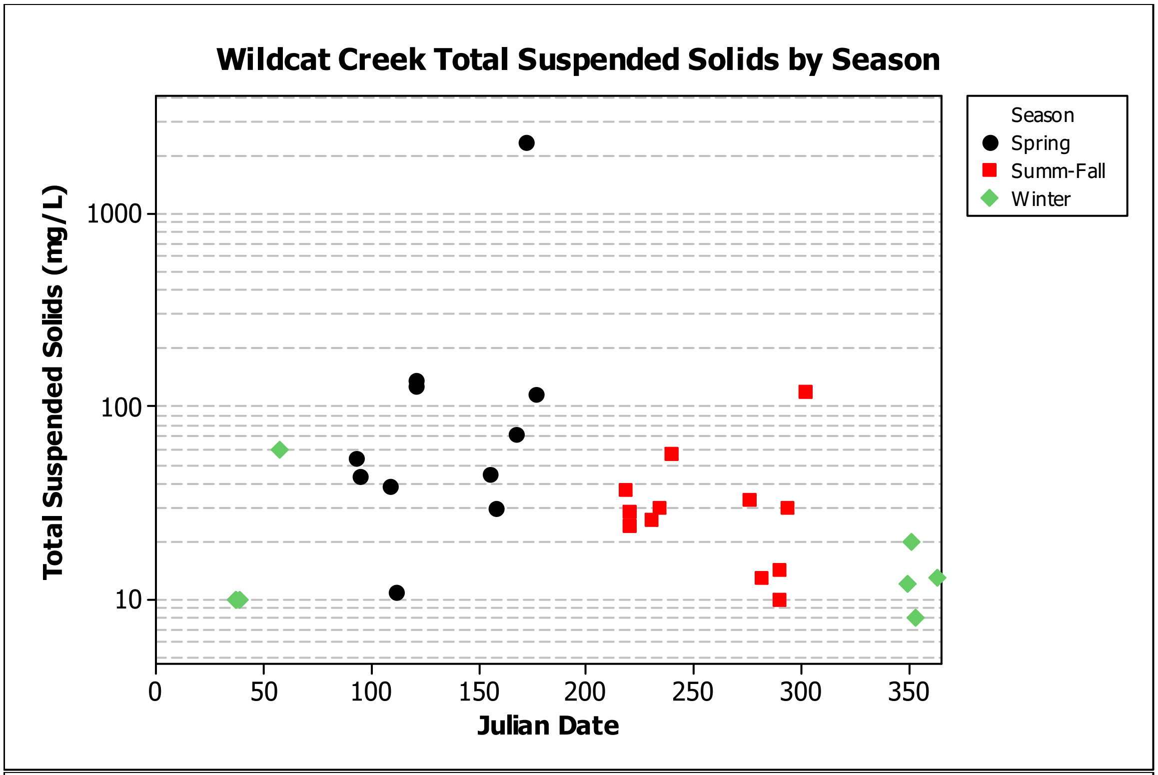
Long-term reductions in dissolved inorganic nitrogen levels may be produced by increased riparian buffering with forest. Once trees develop deep root systems that intercept groundwater flows reductions in inorganic nitrogen loads can be expected. Long-term results may occur with increased use of soil testing to ensure that fertilizer application rates do not exceed crop and urban turf grass needs.

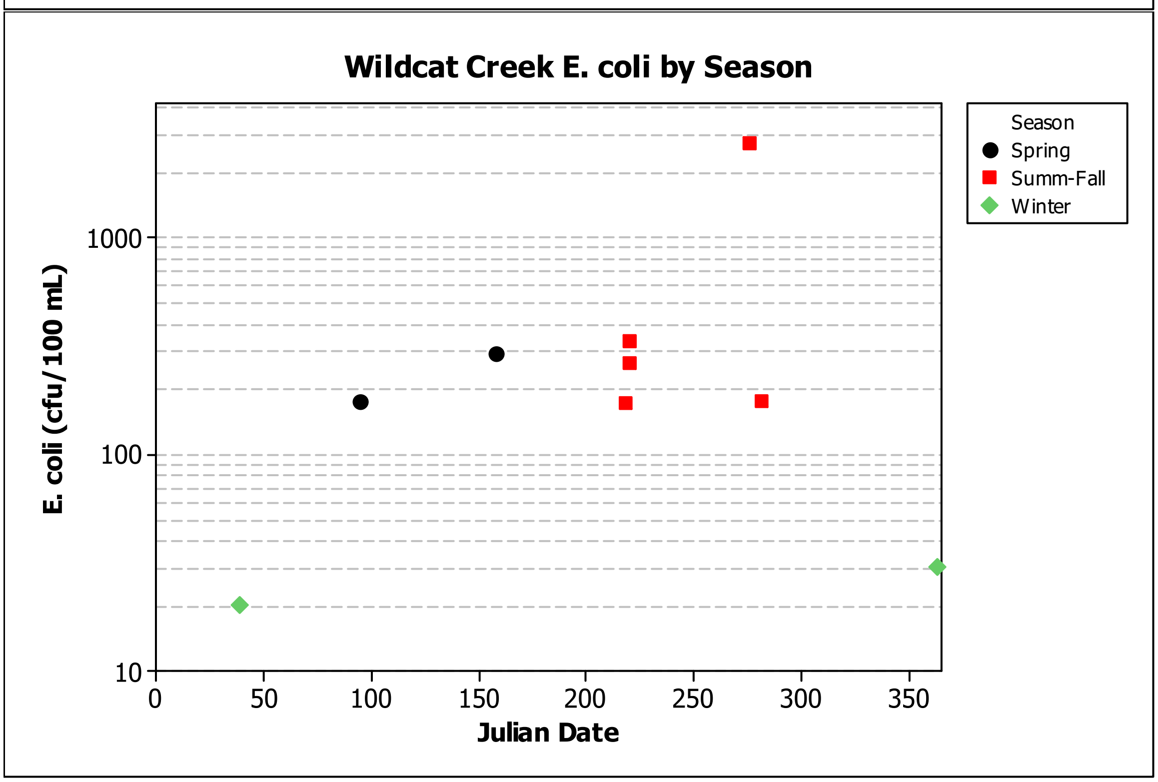
	TP Median	TSS Median	Turbidity Median	TOC Median	Kjeldahl Median	*E.coli* Median	TN Median
Overall	0.185 (31)	30 (31)	14 (31)	3.674 (18)	0.434 (19)	175 (9)	0.658 (19)
Spring	0.191 (11)	54 (11)	20 (11)	5.7595 (6)	0.6355 (6)	235 (2)	0.9225 (6)
Summer Fall	0.1825 (12)	29 (12)	17.35 (12)	4.1865 (8)	0.436 (8)	262 (5)	0.643 (8)
Winter	0.163 (8)	11 (8)	5.63 (8)	3.382 (4)	0.176 (5)	25 (2)	0.326 (5)

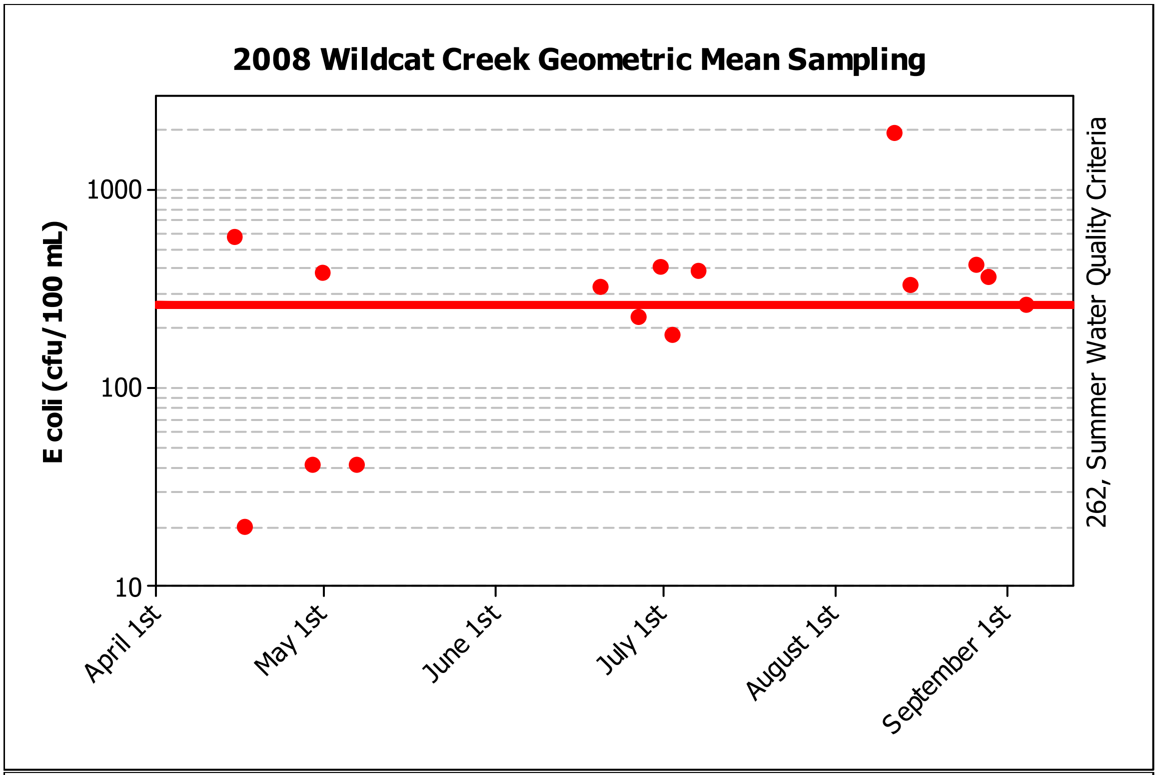
Numbers in parenthesis indicate sample size.

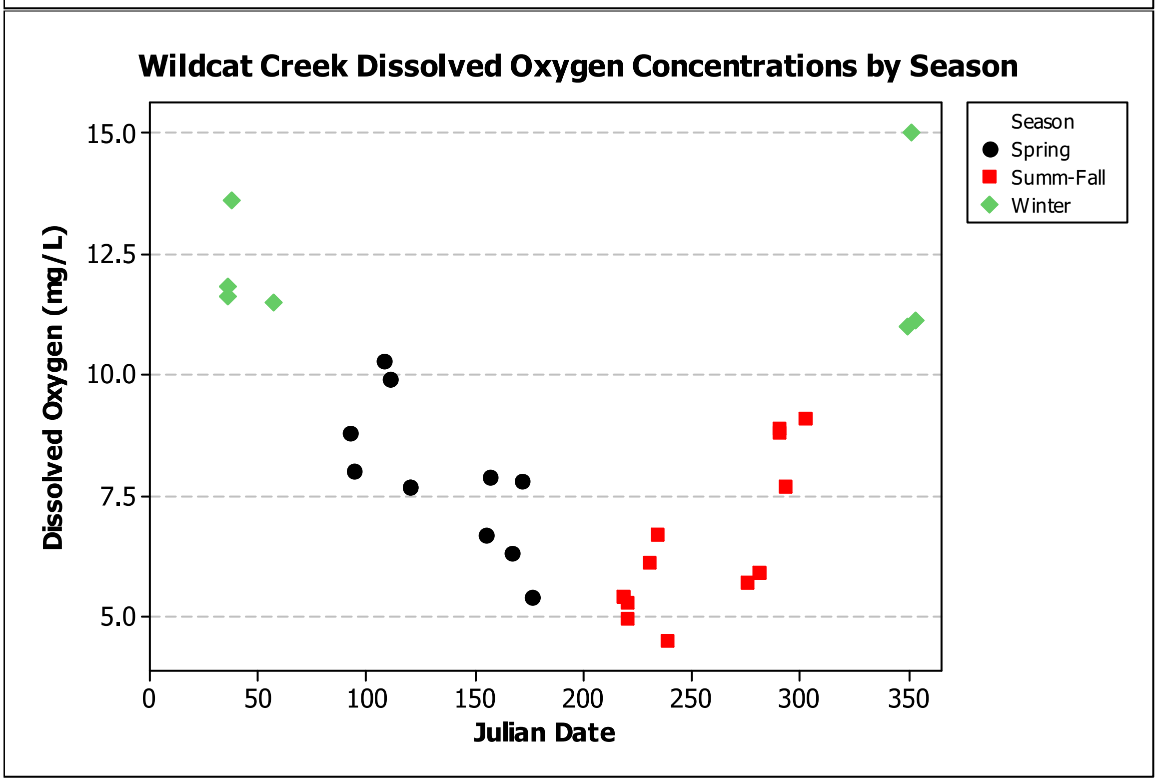

Wildcat Creek Total Phosphorus Concentration by Season
Total Phosphorus (mg/L)
1.0
0.1
0
50
100
150
200
250
300
350
Julian Date
Season
Spring
Summ-Fall
Winter


Wildcat Creek Total Nitrogen Concentrations by Season
Total Ntirogen (mg/L)
10.0
1.0
0.1
0
50
100
150
200
250
300
350
Julian Date
Season
Spring
Summ-Fall
Winter


Wildcat Creek Total Suspended Solids by Season
Total Suspended Solids (mg/L)
1000
100
10
0
50
100
150
200
250
300
350
Julian Date
Season
Spring
Summ-Fall
Winter

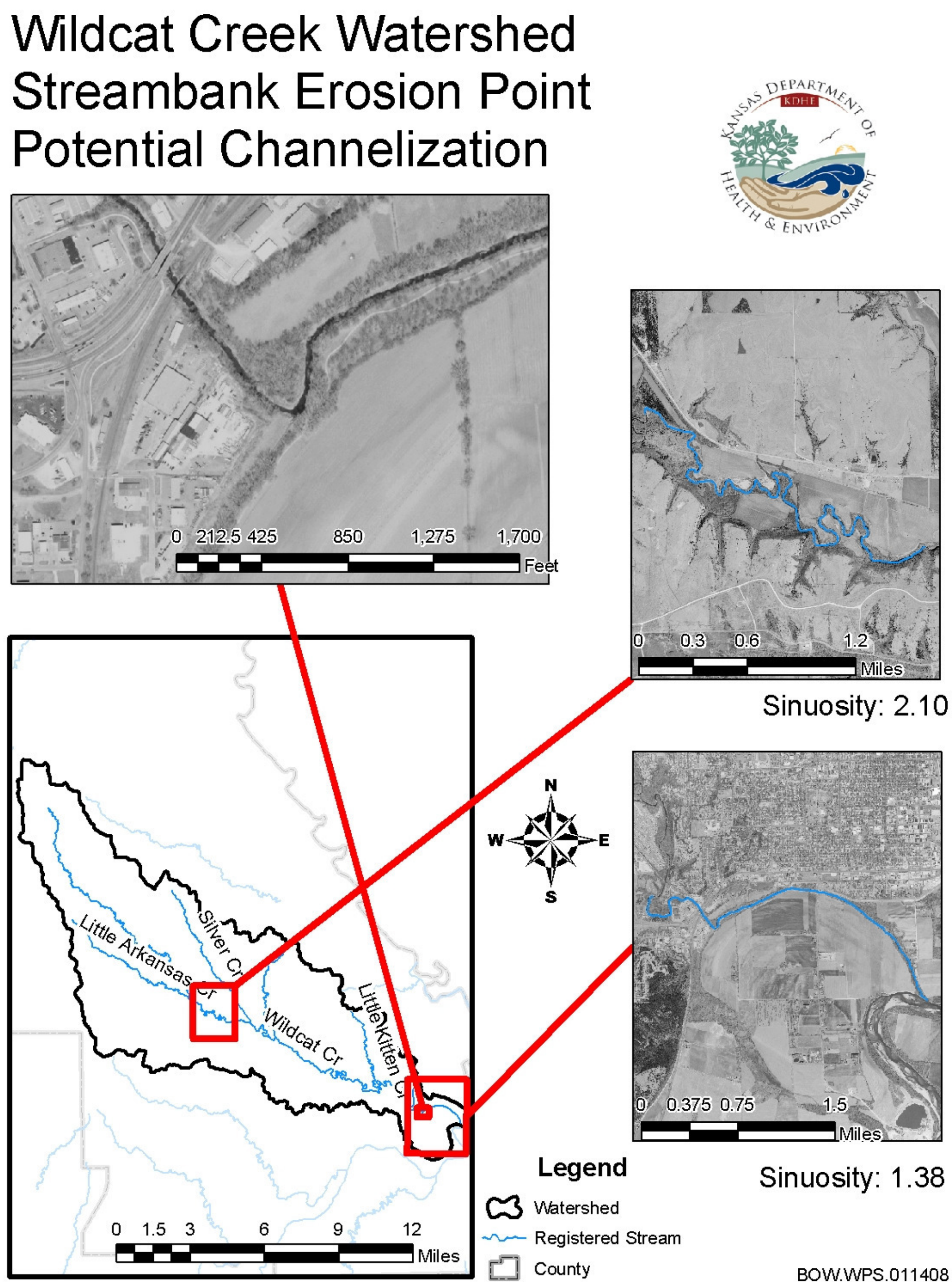

Wildcat Creek E. coli by Season
E. coli (cfu/100 mL)
1000
100
10
0
50
100
150
200
250
300
350
Julian Date
Season
Spring
Summ-Fall
Winter





Streambank stabilization may play an important role in improving water quality in the Wildcat Creek watershed. One meter resolution aerial photographs were used to identify a number of potential unstable streambanks in the lower reaches of the watershed.

Inspection of stream channel sinuosity also suggests that channelization has occurred, and may be contributing to the observed water quality.



Uncertainty-

Because no gage data are available for this stream, some uncertainty exists about the flow conditions associated with the samples. Very large TSS values likely occurred during very high flow events, which may be less responsive to restoration efforts (Meals, 1990). Previous research (unpublished) by KDHE has indicated that median values are strong descriptors of nutrient related impairments, even in the absence of flow data, when large sample records exist. At this level of analysis it is not possible to determine the relative contributions of overland flow, in-stream processes, including collapsing streambanks, and urban specific influences. Nitrogen concentrations are relatively low in comparison to recommended levels for this area, suggesting that groundwater and failing on-site wastewater systems are low concerns for these streams. Future restoration efforts in this area would benefit from more water quality data throughout the watershed to pinpoint potential sources of pollution, and better define the spatial and temporal variation in water quality. Additionally, surveys of stream channel morphology would locate potential sources of major bank instability.

Adapative Implementation Strategies-

Because this stream exhibits characteristics that are consistent with livestock waste loading, unstable streambanks and urban runoff, initial efforts could be focused on working with managers at Ft. Riley, the city of Manhattan, and cattle producers in the watershed. While a large concentration of cropland exists in the upper reaches of this watershed, their apparent contribution to the conditions observed at the monitoring station is low.

Currently a bacteria TMDL exists for this watershed, though it was developed under the previous fecal coliform criteria. Existing data indicate an April through October *E. coli* geometric mean of 324, which exceeds the water quality criteria for primary B waters, though this value is driven by a single sample taken in October of 2007. Without the October 2007 value the geometric mean is 227. However, as noted above, more intensive sampling has confirmed that Wildcat Creek has excessive levels of *E. coli*, and efforts to locate specific sources of the bacteria in the watershed should undertaken to target restoration efforts.

Bacteria may be of particular concern due to the presence of known primary contact recreational activity along the mainstem of Wildcat Creek west of Manhattan. Provision of alternate watering sites, livestock exclusion from streams and ponds, and other efforts to separate cattle from the streams may prove beneficial to reducing the sediment, nutrient and pathogen loading to the streams. Manure management plans for the confined animal operations may also have benefits, depending on their proximity to the stream system.

Because riparian buffering activities typically take three or more years to fully establish themselves, monitoring of post-implementation water quality should be a long-term objective. The existing monitoring record is unlikely to have many high-flow events, due to the design of the sampling program. Because the majority of loads of suspended solids, and total nitrogen are likely to occur during a few, relatively large events, a before- and after- sampling program focused on high flow events would determine if efforts lead to significant improvements to water quality. As is typically the case in the absence of direct inputs nearby, ammonia levels in Wildcat Creek are almost always below KDHE detection limits. Kjeldahl nitrogen typically constitutes 2/3rds of the total nitrogen load, suggesting that measures targeting surface sources of nitrogen, rather than groundwater sources, are most likely to have an impact on conditions seen in these streams. These measures can be expected to be most effective when they intercept or exclude nitrogen sources from sensitive riparian areas.

The lack of strong seasonality to total phosphorus concentrations should not be seen as an indicator that phosphorus concentrations occur at acceptable levels in these streams. Year round concentrations are typically more than twice the concentrations regarded as signifying acceptable water quality. The lack of seasonality leaves some uncertainty about which efforts are most likely to reduce concentrations in this watershed. As mentioned previously, more water quality data from throughout the watershed would help pinpoint the sources of phosphorus contributing to the conditions observed at the monitoring station. Once sources of phosphorus are identified, appropriate strategies for loading reductions can be developed.

This complex watershed has numerous opportunities and challenges urban population centers and federal lands. Efforts to improve water quality are most likely to be successful when a combination of government, private land owner, and urban stakeholder interests work together on this watershed. The involvement of Kansas State University would be beneficial, due to the proximity of both students and researchers within the watershed. The watershed will face ongoing stresses as the city of Manhattan continues to expand westward. Design plans for new developments need to be consistent with water quality protection goals.

Resources for watershed planning in urban watersheds are available at http://www.cwp.org/PublicationStore/USRM.htm